OS - Retrospection

Tid-bits from course outline

This course is oriented towards exposing students to the essential concepts and issues that underly operating systems and their design.

- **Technical**
  - Make students understand the key concepts and mechanisms of modern operating systems:
    - processes and process management,
    - memory management techniques,
    - on-line storage methods (file systems),
    - concurrency issues,
- **Educational**
  - Make students understand the reasons why operating systems are built the way they are, and what the implications and lessons are for other software systems. Specific learning objectives are:
    - appreciation of design trade-offs and design decisions and their dependence on the target environment;
    - exposure to low-level code;
    - exposure to current trends in operating systems research and development.
- **Professional**
  - The tutorial formats will give students practice in the presentation of solutions to an audience of peers, and will challenge them to critique peer technical presentations. Furthermore, the whole course encourages critical examination and analysis of "standard" solutions.
  - The assignments give students an opportunity to develop skills required to work as a team on a technical project, and the opportunity to work with a substantial body of code created by a third-party.

Operating Systems @ CSE.UNSW

Systems Courses

- COMP9242 Advanced Operating Systems
  - In-depth coverage of OS implementation issues
  - Learn more about what makes OS fast and what makes them slow
  - Learn how the OS deals with multiprocessors, caches, virtualisation, etc, etc....
  - Write your own OS on a microkernel
- In Session 2 taught by Prof. Gernot Heiser and Dr. Kevin Elphinstone

- Distributed systems COMP9243
  - Examines issues in building distributed systems and infrastructure
  - Peer-to-peer, web services, network file systems, name services, ……

OS Research ERTOS Group - NICTA

- 9 researchers (PhDs)
- 15 research engineers / research assistants
- 10 PhD students

NICTA at a glance

- NICTA is Australia's National Centre of Excellence in Information and Communication Technology (ICT) Research
- 5 Laboratories:
  - Australian Technology Park Research Laboratory, Sydney
  - Canberra Research Laboratory
  - The Neville Roach Laboratory, UNSW
  - Queensland Research Laboratory
  - Victoria Research Laboratory

The Problem

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Challenges

- Enormous complexity of embedded systems software
  - 5–7Mloc on smartphones
  - Gigabytes of software on cars

- Complexity increasing even in life-critical systems
  - GUIs on medical devices
  - integration of infotainment and control functions in cars

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Challenges

- Mutually untrusted software vendors
- No longer closed systems
  - Download software
- Connectivity
  - Attacks from outside

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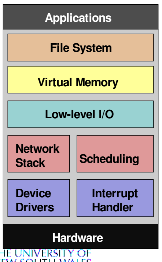
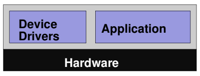
General-Purpose Vs. Embedded

- Traditional View:

General Purpose System



Embedded System



- minimal
- no OS at all or small "real-time executive"
- no protection

Embedded Systems Software

Present Approaches 1: Real-time Executives

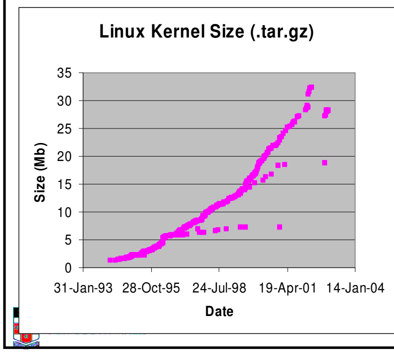
- Small, simple operating system
  - optimised for fast real-time response
  - suitable for systems with very limited functionality
- No internal protection
  - every small bug/failure is fatal
  - no defence against viruses, limited defence against crackers

Embedded Systems Software

Present Approaches 2: Linux, Windows Embedded

- Scaled-down version of desktop operating system
  - operating system protected from application misbehaviour
  - excessive code base for small embedded system
  - too much code on which security of system is dependent
- Dubious or non-existent real-time capabilities
  - unsuitable for hard real-time systems

Linux Kernel Evolution



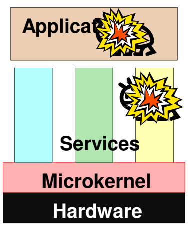
For reference:

Linux 2.4.18 = 2.7 million lines of code

Embedded Systems Software

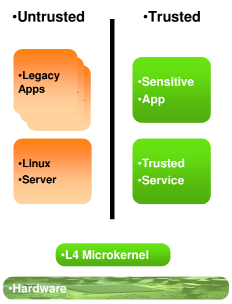
Our Approach: Microkernels

- Extremely small kernel
  - microkernel only contains code that must run in privileged mode
  - all other "systems" code runs as unprivileged servers
  - microkernel protected from application and other systems code
  - microkernel provides protection of all components from each other
  - services can be restarted



Microkernel Approach – L4

- Small trustworthy foundation
  - Applications:
    - Fault isolation
    - Fault identification
    - IP protection
    - Modularity
    - ...
  - High assurance components in presence of other components
- Provides a trustworthy foundation



L4 (UNSW/NICTA) Impact

- Licensed to OK-labs
  - NICTA spinout
  - L4 on 1500 million 3G Handsets
    - Including Android Phones, Windows Phone

Open Kernel Labs
Be open. Be safe.

Why am I telling you this?

Does the following Interest you?

- Gaining in-depth experience in OS research
- Working on a very challenging projects
- Collaborating closely with active researchers
- Getting a high thesis mark
- International travel
- Fame and fortune

Prerequisites

- Keen interest in OS
- Demonstrable background/ability in OS
- Sharp Intellect
- Committed to working on a project

Still Interested?

- Check out

http://www.ertos.nicta.com.au/
specifically the education section.

Apply for a Taste of Research Summer Scholarship
http://www.eng.unsw.edu.au/undergrads/scholarships

On-line Course Surveys

- The on-line course survey will be available
  - My one – in addition to CATEI one
- Please make time to do it
  - Please do the CATEI one as well
- Award 2 bonus class marks to everyone who completes ***my*** survey.
  - You will be emailed an invite

Final Exam

- Tuesday, 19th June, 8:45 – 11:00
- Two Hours
- No examination materials allowed
  - Uni approved calculators okay
- Don't trust me – check the timetable yourself

Exam Format

- Read the instructions on the exam
  - The following details are approximate
- 7 questions
  - 4 should be answered in separate books
  - 2 must be ***answered on the exam paper*** itself.
  - 1 must be answered on the multiple choice answer sheet provided
  - 100-ish Marks in total (total will be scaled to 100)
  - 2 bonus marks for following exam instructions

Exam Format

- Q1 is multiple choice (25% marks)

  You will receive one mark for each correct classification, and lose one mark for each incorrect classification. You gain zero marks for each answer left unclassified. The overall mark for this question will not be negative, i.e. the minimum mark is zero.

Exam Format

- Q2..Q7, roughly:
  - half working out a solution to a problem
  - half written answers to a question
- Some sub questions only for COMP3231/COMP9201 Operating Systems
- Some sub-questions only for COMP3891/COMP9283 Extended Operating Systems

For written answers

- Be clear and concise (get to the point quickly)
  - Long, rambling answers will be penalised

Sample Question

- Name four disk arm scheduling algorithms, and give an advantage or disadvantage of each of them.
- Sample Marking Scheme (out of 8)
  - 2 Marks for each algorithm (1 for the name, 1 for the pro/con)

Reasonable answer

- FCFS, SSTF, SCAN, C-SCAN
- FCFS does not take into account head position, may move head excessively, especially in the case of concurrent applications accessing disk (deteriorates to random). Advantage is that it is fair.
- SSTF reduces head movement by choosing request with shortest seek time first, but may result in starvation of distant requests (e.g if a request is always available nearby)
- SCAN/Elevator better than FIFO, and avoids starvation, but does not take advantage of sequential locality on the down scan
- C-SCAN like SCAN, except avoids disk access on the down-scan and hence improves support for sequential locality

Dumb answers

- FIFO, Clock, EDF, and Two-level scheduling
  - Don't just as add acronyms you can remember

Dumb answers

- Disk arm scheduling algorithms are used to move the head backward and forward on the disk. We can use many different algorithms to decide and some are better than others. One algorithm include first-come first served. It moves the arm to the location on disk in the order the request arrive in, it is bad cause it has overheads. Sometimes requests will be to inside of disk and outside of disk and arm will move far making disk slow. Moving the disk arm is bad.
- SSTF is where disk scheduler chooses block that is closest to disk head and goes there. It is better as is does not move the arm a long way, but has overheads too but not as many as FCFS. It is slow because we must search list of disk requests find the closest one. May cause CPU starvation if we spend to much time searching list and no other programs can run

Answer the question!!!

- Don't repeat the question, we set the exam, we know what it is!!!!
- Don't just write what you know (or don't know) about the topic area
  - You make us have to search for the real answer.
  - You may be correct, but say a lot of unrelated incorrect stuff in the process.
- Don't contradict yourself
  - X is better/faster/more efficient than Y, and later Y is better than X
- Marks are awarded for stating WHY an answer is correct.
  - Demonstrates understanding

Exam Content

- For structure and style, look at the sample exam from past years.
- For content, the tutorial questions are a reasonable *guide*.
- Will be releasing 100-ish sample questions (with student answers).
  - Will attempt to migrate to the wiki
  - Will also answer questions on the forum
    - sometimes difficult to answer without a whiteboard

The questions attempt to examine understanding rather than particular implementations

- Don't expect
  - "Describe OS/161's exception handling on a timer interrupt"
- But you may get
  - "Describe (in general) a feasible sequence of steps that occur in response to a timer interrupt that results in the current process being pre-empted and a another process running"

Examinable Content

- All Lectures, Tutorials, Assignments.
- More specifically
  - Anything related to learning outcomes